

Physics 30 Physics 30

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# June 1998



# Physics 30

## Grade 12 Diploma Examination

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**June 1998**

# **Physics 30**

## **Grade 12 Diploma Examination**

### **Description**

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

Total possible marks: 70

This is a **closed-book** examination consisting of

- 37 multiple-choice and 12 numerical-response questions, of equal value, worth 70% of the examination
- 2 written-response questions, worth a total of 30% of the examination

This examination contains sets of related questions. A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

A tear-out data sheet is included near the back of this booklet. A Periodic Table of the Elements is also provided.

The blank perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

### **Instructions**

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

## Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

### Example

This examination is for the subject of

- A. biology
- B. physics
- C. chemistry
- D. science

#### Answer Sheet

- (A)
- (B)
- (C)
- (D)

## Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.

## Examples

### Calculation Question and Solution

If a 121 N force is applied to a 77.7 kg mass at rest on a frictionless surface, the acceleration of the mass will be \_\_\_\_\_ m/s<sup>2</sup>.

(Round and record your answer to three digits.)

$$a = \frac{F}{m}$$

$$a = \frac{121 \text{ N}}{77.7 \text{ kg}} = 1.5572716$$

#### Record 1.56 on the

answer sheet →

1.56



### Calculation Question and Solution

A microwave of wavelength 16 cm has a frequency, expressed in scientific notation, of  $b \times 10^w$  Hz. The value of  $b$  is \_\_\_\_\_.

(Round and record your answer to two digits.)

$$f = \frac{c}{\lambda}$$

$$f = \frac{3.00 \times 10^8 \text{ m/s}}{0.16 \text{ m}} = 1.875 \times 10^9$$

#### Record 1.9 on the

answer sheet →

1.9



## **Correct-Order Question and Solution**

Place the following types of EMR in order of increasing energy:

- 1 blue light
- 2 gamma radiation
- 3 radio waves
- 4 ultraviolet radiation

(Record your answer as **□ □ □ □**.)

Answer: 3142

Record 3142 on the  
answer sheet → **3 | 1 | 4 | 2**

•	•		
0	0	0	0
1	●	1	1
2	2	2	●
●	3	3	3
4	4	●	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

## **Scientific Notation Question and Solution**

A hydrogen-like atom whose 3-2 transition emits light at 164 nm would have an  $E_1$  value of  $-a.b \times 10^{-d}$  J. The values of  $a$ ,  $b$ ,  $c$ , and  $d$ , are \_\_\_\_\_.

(Record your answer as **a | b | c | d**.)

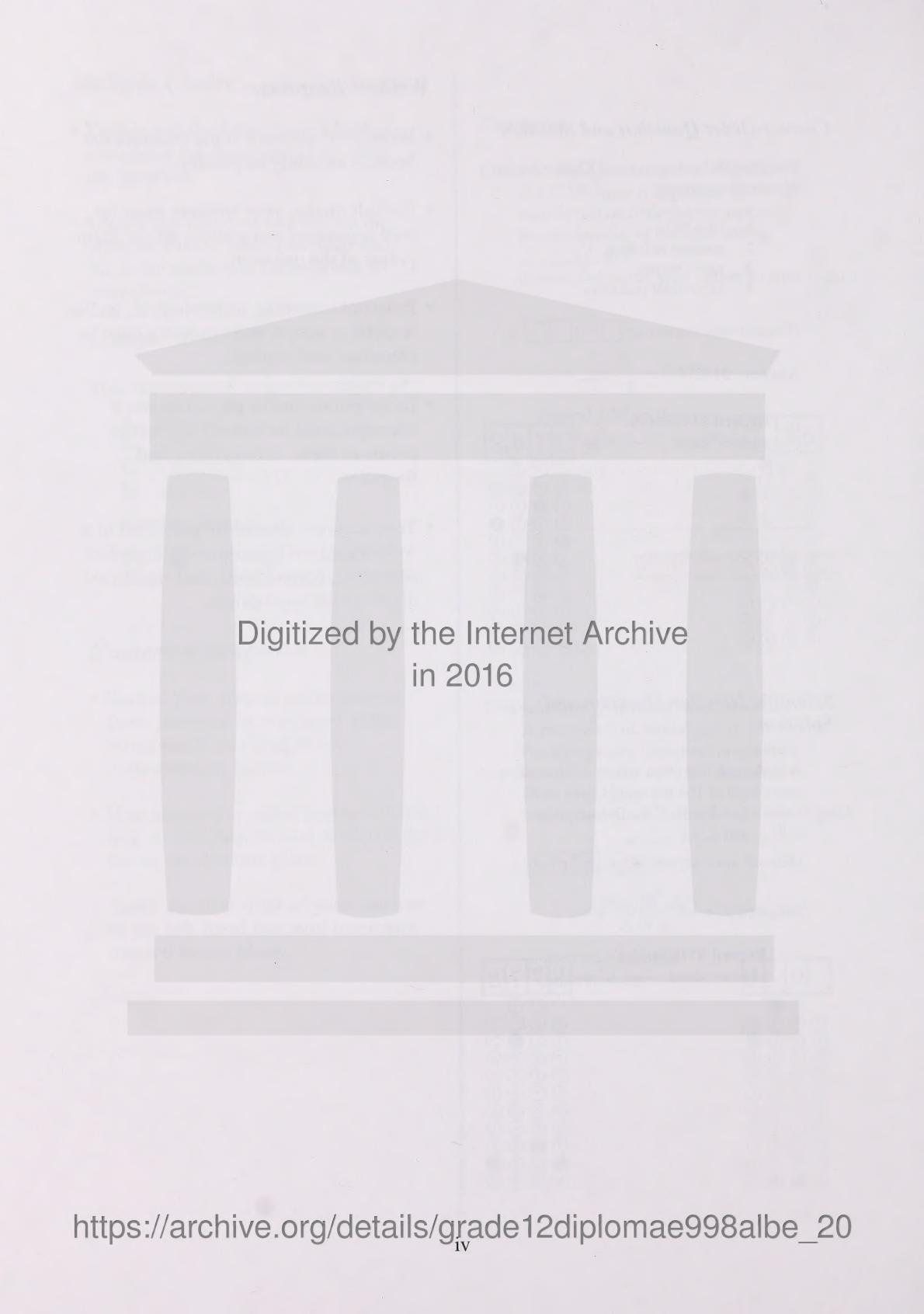
Answer:  $E_1 = -8.7 \times 10^{-18}$  J

Record 8718 on the  
answer sheet → **8 | 7 | 1 | 8**

•	•		
0	0	0	0
1	1	●	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	●	7	7
●	8	8	●
9	9	9	9

## **Written Response**

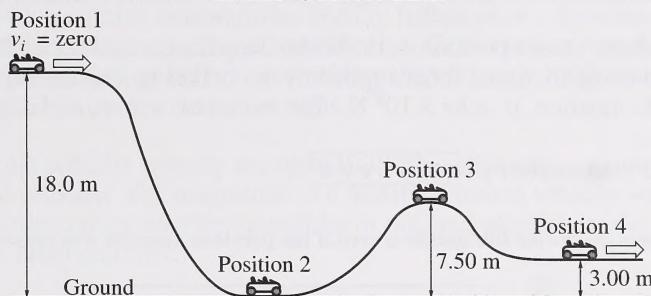
- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and explicit.
- Descriptions and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should** be presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.



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Use the following information to answer the next three questions.

### Roller-Coaster Ride



A 250 kg roller-coaster car starts at position 1 and continues through the entire track. The brakes are applied after the car passes position 4. Assume that the effects of friction on the roller-coaster car are negligible between positions 1 and 4.

#### Numerical Response

1. When placed in order from **greatest** amount of kinetic energy to **least**, the order of the four different positions of the roller-coaster car labelled on the diagram is \_\_\_\_\_.

(Record your answer as    .)

1. The roller-coaster car's speed at position 4, immediately before the brakes are applied, is

- A. 18.8 m/s
- B. 17.2 m/s
- C. 13.3 m/s
- D. 12.1 m/s

## Numerical Response

Use your recorded answer from **Multiple Choice 1** to answer **Numerical Response 2**.\*

2. After the car passes position 4, the brakes stop the car in 3.03 s. The magnitude of the average frictional force applied by the brakes to stop the car, expressed in scientific notation, is  $a.bc \times 10^d$  N. The values of  $a$ ,  $b$ ,  $c$ , and  $d$  are \_\_\_\_\_.

(Record your answer as **[a]** **[b]** **[c]** **[d]**.)

\*You can receive marks for this question even if the previous question was answered incorrectly.

---

2. Ruth is diving from a tower 10.0 m above the water. When she is 5.0 m above the surface of the water, her

- A. momentum and kinetic energy are about equal
- B. velocity is half of the velocity she will have when she touches the water
- C. potential energy, with respect to the water, and her momentum are about equal
- D. potential energy, with respect to the water, and her kinetic energy are about equal

Use the following information to answer the next question.

- I. Energy
- II. Displacement
- III. Mass
- IV. Acceleration
- V. Force

3. Which of the above terms represent scalar quantities?

- A. I and III only
- B. III and V only
- C. I, II, and III only
- D. II, IV, and V only

*Use the following information to answer the next three questions.*

In some parts of the world, it is common for people to shoot firearms straight up into the air during celebrations. Falling bullets pose a significant danger to bystanders. Doctors at King/Drew Medical Center in Los Angeles treated 118 people for falling-bullet injuries from 1985 through 1992, and 38 of these people died. All were random victims.

As a bullet falls, its velocity increases until it reaches a maximum, called terminal velocity. The magnitude of a bullet's terminal velocity will depend on its calibre (size), whether it tumbles or not, and whether it falls nose- or blunt-end first.

A 2.00 g bullet fired from a rifle with an initial velocity of 841 m/s travels straight up and reaches an altitude of  $2.80 \times 10^3$  m. As it falls, it reaches its terminal velocity of 210 m/s.

### Numerical Response

3. The rifle has a mass of 3.80 kg. The recoil speed of the rifle, expressed in scientific notation, is  $a.bc \times 10^{-d}$  m/s. The values of  $a$ ,  $b$ ,  $c$ , and  $d$  are \_\_\_\_\_.

(Record your answer as  $\boxed{a} \boxed{b} \boxed{c} \boxed{d}$ .)

4. How much energy is lost as a result of air resistance as the bullet rises to its maximum altitude?

A. 54.9 J  
B. 652 J  
C. 707 J  
D. 762 J

5. What percentage of energy is lost **during the entire flight** of the bullet?

A. 98.4%  
B. 93.8%  
C. 92.2%  
D. 87.0%

*Use the following information to answer the next two questions.*

A 1 000 kg car travelling east at 29.4 m/s on an icy road hits a parked truck that has a mass of 1 500 kg. Immediately after the collision, the car was moving at 20.0 m/s in the direction 20.0° N of E, and the truck was moving at an unknown speed in the direction 45.0° S of E.

6. What physics principles do police use to determine the speed of the truck?

- A. Conservation of kinetic energy but not conservation of momentum
- B. Conservation of momentum but not conservation of kinetic energy
- C. Both conservation of momentum and conservation of kinetic energy
- D. Neither conservation of momentum nor conservation of kinetic energy

**Numerical Response**

4. The magnitude of the total momentum before the collision, expressed in scientific notation, is  $a.bc \times 10^d$  kg•m/s. The values of  $a$ ,  $b$ ,  $c$ , and  $d$  are \_\_\_\_\_.

(Record your answer as  $\boxed{a} \boxed{b} \boxed{c} \boxed{d}$ .)

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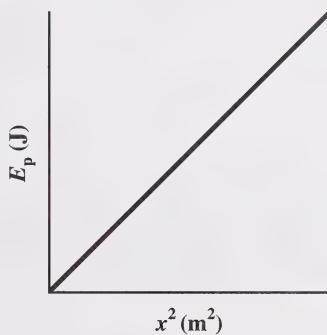
7. When a charged particle accelerates in an electric field, there is a **decrease** in its

- A. mass
- B. charge
- C. kinetic energy
- D. potential energy

*Use the following information to answer the next question.*

A student has learned that the elastic potential energy stored in a spring is determined by the equation  $E_p = \frac{1}{2}kx^2$ , where  $x$  is the displacement of the spring from its resting (equilibrium) position and  $k$  is the spring constant for the spring. She conducts an experiment in which she stretches a spring to different lengths and determines the spring's elastic potential energy at each length. Using her data, she plots the following graph.

**Potential Energy as a Function of the Square of the Extension**



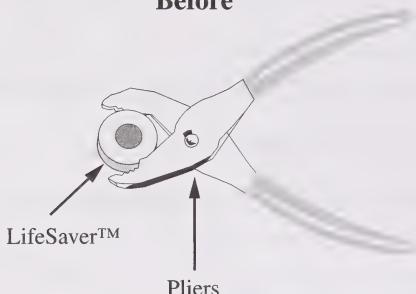
8. The student calculates the slope of the best-fit line. What calculation would she have to make to use this slope value to determine the value of the spring constant?

- A. Divide the slope by 2.
- B. Divide the slope by  $x^2$ .
- C. Multiply the slope by 2.
- D. Multiply the slope by  $x^2$ .

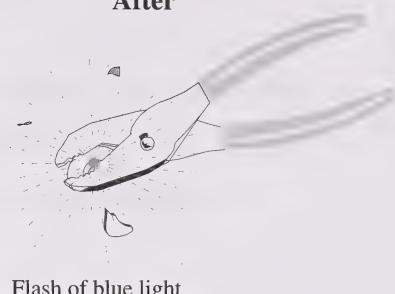
Use the following information to answer the next four questions.

When a “LifeSavers™ WintOgreen” candy is crushed with pliers in a totally darkened room, a flash of blue light will be observed.

**Before**



**After**



—Hershey Canada Inc.

9. If an average force of 100 N is applied on the handles of the pliers, moving them together through a distance of 4.50 mm, and if the pliers are 35% efficient, then how much energy is transferred to the actual “crushing” of the LifeSavers™ candy?

A.  $4.5 \times 10^2$  J  
B.  $1.6 \times 10^2$  J  
C.  $4.5 \times 10^{-1}$  J  
D.  $1.6 \times 10^{-1}$  J

**Numerical Response**

5. If the jaws of the pliers exert an average force on the LifeSavers™ candy of  $8.50 \times 10^2$  N for  $1.25 \times 10^{-1}$  s, then the impulse imparted to the LifeSavers™ candy, expressed in scientific notation, is  $a.bc \times 10^d$  N•s. The values of  $a$ ,  $b$ ,  $c$ , and  $d$  are \_\_\_\_\_.

(Record your answer as **[a]** **[b]** **[c]** **[d]**.)

*Use the following additional information to answer the next question.*

As the LifeSavers™ candy is crushed, electrons are released and collide with nitrogen molecules in the air. These collisions cause the nitrogen molecules to emit ultraviolet radiation.

10. The emission of an ultraviolet photon from a nitrogen molecule is a result of

- A. electron transitions from a lower energy level to a higher energy level
- B. electron transitions from a higher energy level to a lower energy level
- C. nuclear fusion of the absorbed electron
- D. radioactive decay in the nucleus

*Use the following additional information to answer the next question.*

The ultraviolet radiation emitted by the nitrogen molecules is absorbed by atoms in the oil of wintergreen found in the LifeSavers™ candy. The atoms in the oil of wintergreen immediately re-emit some of this energy as a flash of blue light.

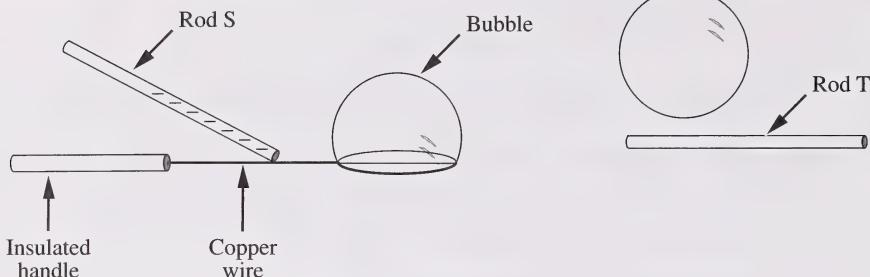
### Numerical Response

6. The atoms in the oil of wintergreen absorb ultraviolet radiation with a frequency of  $8.50 \times 10^{14}$  Hz and re-emit blue light with a frequency of  $7.50 \times 10^{14}$  Hz. The energy difference in the conversion, expressed in scientific notation, is  $b \times 10^{-w}$  J. The value of  $b$  is \_\_\_\_\_.

(Round and record your answer to three digits.)

*Use the following information to answer the next question.*

### Electrostatic Forces



A soap bubble rests on a loop of copper wire. After the wire is touched with negatively charged rod S, the bubble is freed and suspended electrostatically above rod T.

11. The bubble is suspended because

- A. rod T is negatively charged and repels the negative charges on the bubble
- B. rod T is positively charged and repels the positive charges on the bubble
- C. the bubble induces a negative charge on rod T and is held up by repulsion
- D. the bubble induces a positive charge on rod T and is held up by repulsion

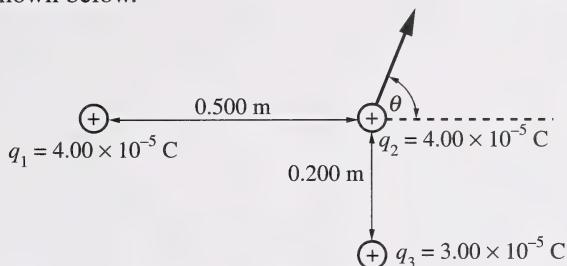
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12. The relationship between the electrical force,  $F$ , on two small, charged objects and their distance of separation,  $r$ , is represented by

- A.  $F \propto r$
- B.  $F \propto 1/r$
- C.  $F \propto r^2$
- D.  $F \propto 1/r^2$

*Use the following information to answer the next two questions.*

Three charges,  $q_1$ ,  $q_2$ , and  $q_3$ , are placed at the vertices of a right angle triangle, as shown below.



13. The magnitude of the net electrostatic force acting on  $q_2$  is

- A. 212 N
- B. 263 N
- C. 276 N
- D. 327 N

**Numerical Response**

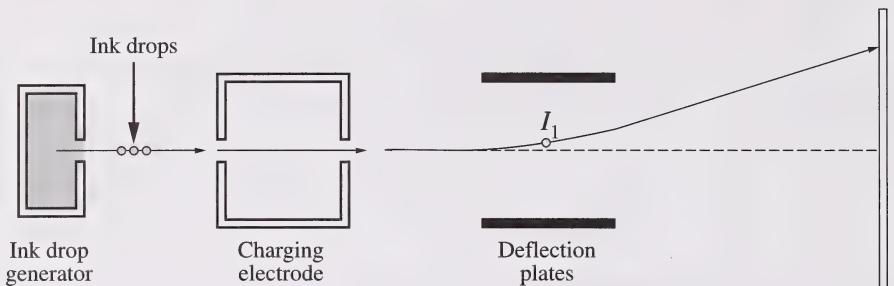
7. The angle labelled  $\theta$  indicates the direction of the net electrostatic force on  $q_2$ .  
The value of  $\theta$  is \_\_\_\_\_°.

(Round and record your answer to three digits.)

Use the following information to answer the next four questions.

### Side View of the Components of an Ink-Jet Printer

The essential components of one type of ink-jet printer are shown below.



Ink drops from the generator pass through a charging electrode. By means of a signal from a computer, the charging electrode controls the charge given to the ink drops. Ink drops are deflected between the deflection plates. The amount each drop is deflected determines where it strikes the paper. A typical ink drop has a mass of  $1.32 \times 10^{-10}$  kg. Approximately 100 ink drops are needed to form a single letter on paper.

Ink drop  $I_1$  has a charge of  $-1.51 \times 10^{-13}$  C.

### Numerical Response

8. The number of excess electrons given to ink drop  $I_1$  expressed in scientific notation, is  $a.bc \times 10^d$  electrons. The values of  $a$ ,  $b$ ,  $c$ , and  $d$  are \_\_\_\_\_.

(Record your answer as  $\boxed{a} \boxed{b} \boxed{c} \boxed{d}$ .)

**14.** The deflection plates are 0.100 mm apart, and there is a potential difference of 120 V across them. The magnitude of the electric field between the plates is

- A.  $1.20 \times 10^6$  N/C
- B.  $1.20 \times 10^3$  N/C
- C.  $1.20 \times 10^1$  N/C
- D.  $1.20 \times 10^{-2}$  N/C

*Use your recorded answer for **Multiple Choice 14** to solve **Multiple Choice 15**.\**

**15.** As the charged ink drop,  $I_1$ , moves through the deflection plates, it experiences a force with a magnitude of

- A.  $1.81 \times 10^{-15}$  N
- B.  $1.81 \times 10^{-12}$  N
- C.  $1.81 \times 10^{-10}$  N
- D.  $1.81 \times 10^{-7}$  N

**\*You can receive marks for this question even if the previous question was answered incorrectly.**

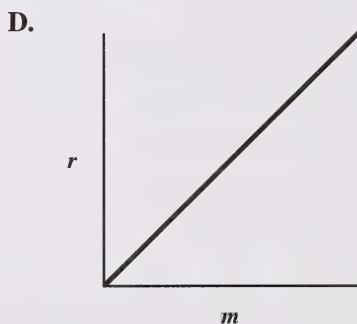
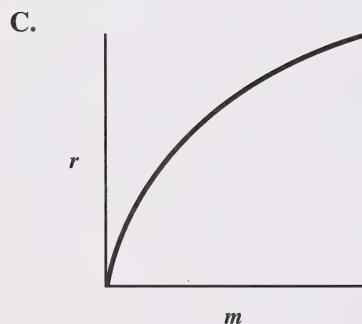
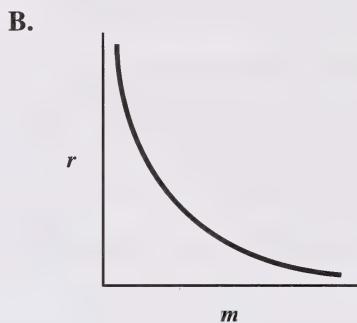
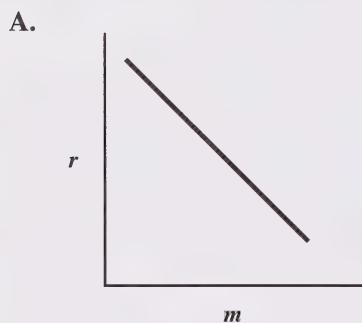
**16.** To cause ink drop  $I_1$  to follow the path shown, the direction of the **electric field** between the charged deflection plates must be toward the

- A. bottom of the page
- B. top of the page
- C. right of the page
- D. left of the page

17. In all circuits that have a constant resistance, the power varies

- A. directly as the square of the current
- B. inversely as the square of the current
- C. directly as the square root of the current
- D. inversely as the square root of the current

18. Ions, each having a single charge, are accelerated to a given speed. They then enter a magnetic field in a direction perpendicular to the field. The radius of the curved path of each ion is measured. The graph that **best** shows the relationship between the mass of an ion and the radius of its path is

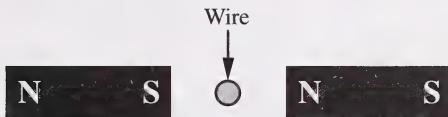


**19.** Magnets can be produced when small magnetic regions in a metal line up their poles. These magnetic regions are called magnetic

- A. domains
- B. fields
- C. atoms
- D. areas

*Use the following information to answer the next question.*

**Cross-Section of a Wire Suspended in a Magnetic Field**



A wire is placed between two permanent magnets. As shown in the diagram, it is positioned so that it is perpendicular to the magnetic field and to the page. The mass of the wire is 0.850 g. The length of the wire perpendicular in the magnetic field is 1.30 cm. The resistance of the wire is  $1.20 \Omega$ .

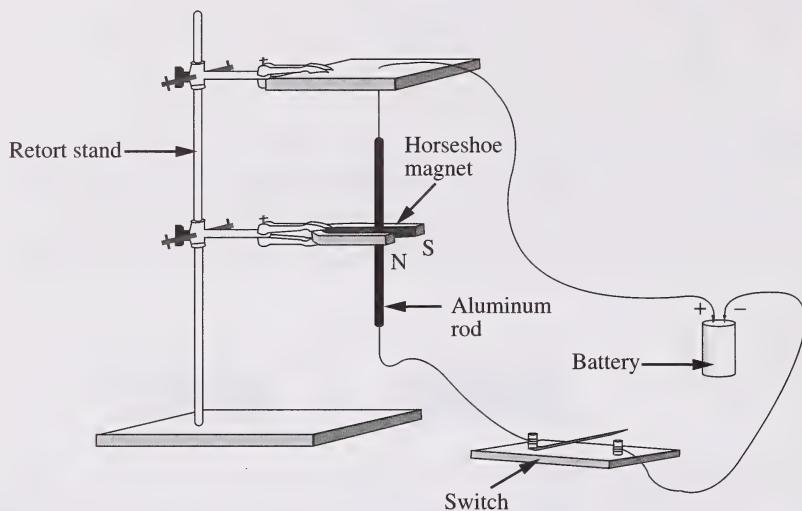
**Numerical Response**

**9.** When a potential difference of 12.0 V is applied to the wire, there is sufficient magnetic force to keep the wire supported against gravity. The magnitude of the magnetic field, expressed in scientific notation, is  $a.bc \times 10^{-d}$  T. The values of  $a$ ,  $b$ ,  $c$ , and  $d$  are \_\_\_\_\_.

(Record your answer as  $\boxed{a} \boxed{b} \boxed{c} \boxed{d}$ .)

*Use the following information to answer the next question.*

The diagram below shows an experimental design used to investigate the effect of a magnetic field on a vertical current-carrying conductor. The aluminum rod is able to swing freely.



20. When the switch is closed, a current in the circuit causes the bottom end of the aluminum rod to swing

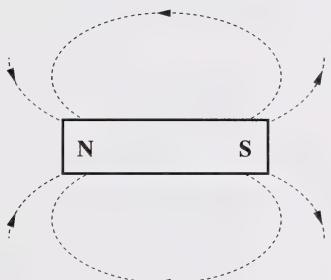
- A. toward the retort stand
- B. away from the retort stand
- C. toward the south pole of the magnet
- D. toward the north pole of the magnet

21. The power line that supplies power to a school has a voltage of  $7.20 \times 10^3$  V. The transformer between the school and the line reduces this voltage to  $2.40 \times 10^2$  V. If an ideal transformer delivers  $3.84 \times 10^3$  J of energy every second to the school, then the current in the primary coil of the transformer is

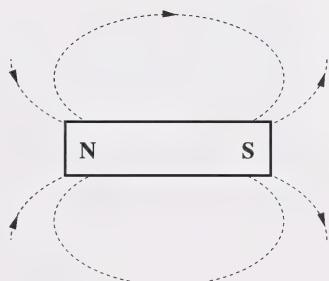
- A. 16.0 A
- B. 1.88 A
- C. 0.533 A
- D. 0.0625 A

22. Which of the following diagrams illustrates the magnetic field surrounding a bar magnet?

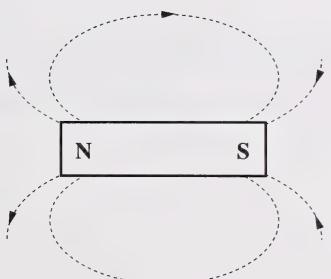
A.



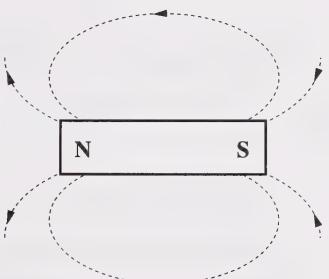
B.



C.

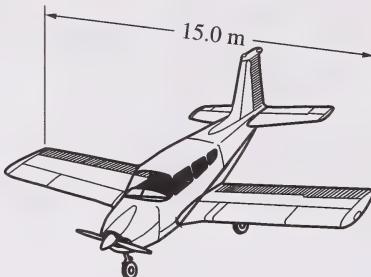


D.



*Use the following information to answer the next question.*

A plane has a wing span of 15.0 m. While flying directly over the north magnetic pole at 250 km/h, a potential difference is induced between the plane's wing tips. Earth's magnetic field at this position is  $6.0 \times 10^{-5}$  T and is perpendicular to the path of the plane.



23. The potential difference between the wing tips is

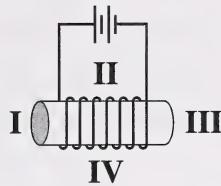
- A.  $2.8 \times 10^5$  V
- B.  $7.7 \times 10^4$  V
- C.  $2.3 \times 10^{-1}$  V
- D.  $6.3 \times 10^{-2}$  V

---

24. A stream of electrons with a given speed,  $v$ , enters a magnetic field of known intensity,  $B$ . The direction of the motion of the electrons is perpendicular to the direction of the magnetic field. Changes are made to both  $B$  and  $v$ . The radius of the circular path of the electrons will always increase when

- A.  $B$  increases and  $v$  increases
- B.  $B$  increases and  $v$  decreases
- C.  $B$  decreases and  $v$  increases
- D.  $B$  decreases and  $v$  decreases

**25.** The north pole of the solenoid shown below is at position



- A. I
- B. II
- C. III
- D. IV

**26.** The wavelength of ultraviolet light is

- A. shorter than that of visible light and longer than that of gamma rays
- B. longer than that of visible light and shorter than that of gamma rays
- C. shorter than that of visible light and longer than that of infrared rays
- D. longer than that of visible light and longer than that of infrared rays

*Use the following information to answer the next two questions.*

### Microwave Communication

A microwave generator emits photons that each have  $4.37 \times 10^{-23}$  J of energy. Some of these photons are detected by a microwave receiver placed 50.0 km away.



27. The time it takes microwave photons to travel from the generator to the receiver is

- A.  $6.00 \times 10^{-4}$  s
- B.  $5.10 \times 10^{-4}$  s
- C.  $3.33 \times 10^{-4}$  s
- D.  $1.67 \times 10^{-4}$  s

### Numerical Response

10. The frequency of the microwave photons, expressed in scientific notation, is  $b \times 10^w$  Hz. The value of  $b$  is \_\_\_\_\_.

(Round and record your answer to three digits.)

**28.** Maxwell proposed the theory that an oscillating electric field generates a

- A. parallel electric charge
- B. constant magnetic field
- C. changing magnetic field
- D. perpendicular electric charge

**Numerical Response**

**11.** In a magnetic field with a strength of  $5.60 \times 10^{-2}$  T, an alpha particle travels in a circular path with a radius of  $6.40 \times 10^{-3}$  m. The speed of the alpha particle, expressed in scientific notation, is  $b \times 10^w$  m/s. The value of  $b$  is \_\_\_\_\_.

(Round and record your answer to three digits.)

**29.** Some cellular phones operate in the  $9.0 \times 10^2$  MHz band of the electromagnetic spectrum. The energy associated with each photon of this frequency is approximately

- A.  $1.4 \times 10^{-15}$  eV
- B.  $1.4 \times 10^{-13}$  eV
- C.  $3.7 \times 10^{-8}$  eV
- D.  $3.7 \times 10^{-6}$  eV

30. The property of cathode rays that provides the **best** evidence to suggest that they are **not** electromagnetic radiation, is that they

- A. are emitted by a variety of cathode materials
- B. move between electrodes at high speeds
- C. can be deflected by a magnetic field
- D. tend to travel in straight lines

31. The charge and the approximate diameter of a nucleus may be estimated from

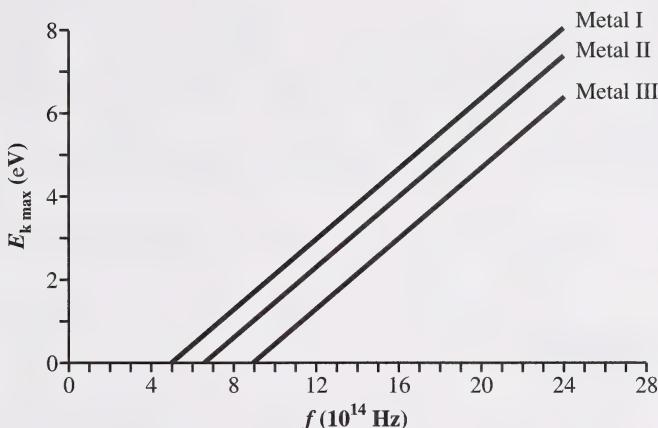
- A. alpha particle scattering experiments
- B. X-ray diffraction experiments
- C. photoelectron experiments
- D. cathode-ray experiments

32. The minimum frequency of incident radiation required to raise an electron in a hydrogen atom from the ground state to the third energy level is approximately

- A.  $1.0 \times 10^{-7}$  Hz
- B.  $3.3 \times 10^{-2}$  Hz
- C.  $3.1 \times 10^1$  Hz
- D.  $3.0 \times 10^{15}$  Hz

*Use the following information to answer the next question.*

### Maximum Kinetic Energy versus Frequency



The graph shows how the maximum kinetic energy of photoelectrons depends upon the frequency of the incident radiation for three different metals.

33. Which of the metals will emit photoelectrons when illuminated by visible light?

- A. I only
- B. III only
- C. I and II only
- D. II and III only

*Use the following information to answer the next three questions.*

### **Photochromic Glasses**

Photochromic glasses are eyeglasses that darken automatically when exposed to bright sunlight. The special glass in these eyeglasses contains crystals of silver chloride ( $\text{AgCl}$ ). When the glass is exposed to sunlight, the silver ions ( $\text{Ag}^+$ ) are converted to atoms of metallic silver ( $\text{Ag}_{(s)}$ ), which are dark. This process darkens the glass. The amount of energy required to convert one silver ion ( $\text{Ag}^+$ ) to one metallic silver atom ( $\text{Ag}_{(s)}$ ) is  $1.21 \times 10^{-18}$  J.

When the eyeglasses are moved out of the bright sunlight, they lighten automatically.

### **Numerical Response**

**12.** The minimum frequency of light required to darken the glasses, expressed in scientific notation, is  $b \times 10^w$  Hz. The value of  $b$  is \_\_\_\_\_.

(Round and record your answer to three digits.)

**34.** When the eyeglasses are worn indoors, they do not darken. This is because the photons from incandescent bulbs have

- A. sufficient energy to convert  $\text{Cl}^-$  ions to  $\text{Cl}$  atoms
- B. insufficient energy to pass through the special glass
- C. insufficient energy to continue to convert  $\text{Ag}^+$  ions to  $\text{Ag}$  atoms
- D. sufficient energy to cause photoelectric emission of the  $\text{Ag}$  atoms

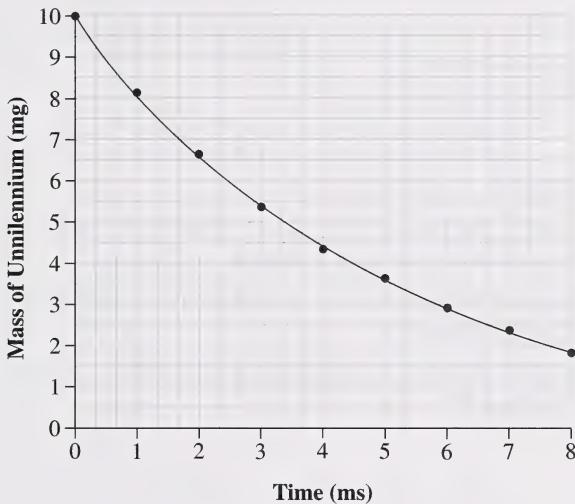
**35.** The type of electromagnetic radiation present in sunlight that is required to darken photochromic glasses is

- A. infrared
- B. ultraviolet
- C. microwave
- D. visible light

Use the following information to answer the next two questions.

As artificial elements are created, they are added to the periodic table. In 1982, the 109<sup>th</sup> element, unnilennium, was created. It was found that unnilennium emits alpha particles as it decays.

### Radioactive Decay of Unnilennium



36. The nuclear equation describing this decay is

- A.  ${}_{109}^{266}\text{Une} \rightarrow {}_{107}^{262}\text{Uns} + {}_2^4\text{He}$
- B.  ${}_{109}^{266}\text{Une} \rightarrow {}_{110}^{266}\text{Und} + {}_{-1}^0\text{e}$
- C.  ${}_{109}^{266}\text{Une} \rightarrow {}_{109}^{266}\text{Une} + \gamma$
- D.  ${}_{109}^{266}\text{Une} \rightarrow {}_{108}^{265}\text{Uno} + {}_1^1\text{H}$

37. As determined from the graph, the half-life of unnilennium is between

- A. 1 ms and 2 ms
- B. 2 ms and 3 ms
- C. 3 ms and 4 ms
- D. 4 ms and 5 ms

*Use the following information to answer the next question.*

A site contains soil that is radioactive. The soil may be emitting one or more of alpha particles, beta particles, or gamma rays. As the physics expert for the clean-up crew, you have been provided with a sample of the soil for analysis. The sample is placed inside a specially designed container that permits radiation particles and rays to exit only in a straight-line path. Your laboratory contains all other necessary apparatus.

**Written Response – 15%**

**1.** Describe a procedure for determining which types of radiation are being emitted by the soil sample. Include:

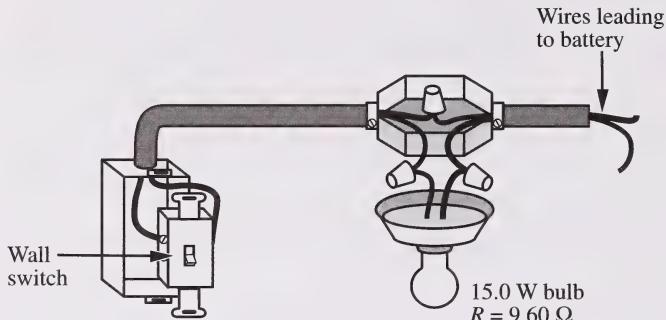
- a safety note to the rest of the clean-up crew describing the dangers associated with **one** of the three forms of radiation
- a description of the method you would use to identify alpha particles, beta particles, and gamma rays
- an explanation of how you would use your results to identify the types of radiation emitted by the soil

Note: A maximum of 8 marks will be awarded for the physics used to solve this problem. A maximum of 3 marks will be awarded for the effective communication of your response.

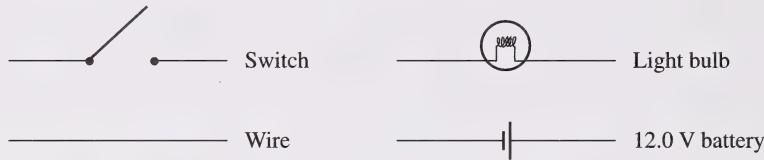


*Use the following information to answer the next question.*

The diagram below illustrates how a single light fixture is connected to a battery and switch, as might be found in a recreational vehicle (RV).



The following schematic symbols represent circuit components.



**Written Response – 15%**

**2.**

- Using the symbols shown above, draw and label a schematic diagram representing this circuit.
- Draw and label a second schematic diagram containing one switch, the 12.0 V battery, and a 3.0 W nightlight bulb in parallel with the 15.0 W bulb. Design this two-light-bulb circuit so that the switch controls only the 15.0 W bulb.
- Describe what happens to the 3.0 W bulb and the 15.0 W bulb when the switch is open and when it is closed in the two-light-bulb circuit.
- Calculate the total power, total current, and total resistance of the two-light-bulb circuit when the switch is closed.

**Clearly communicate your understanding of the physics principles that you are using to solve this question. You may communicate this understanding mathematically, graphically, and/or with written statements.**

*You have now completed the examination.  
If you have time, you may wish to check your answers.*



Fold and tear along perforation.

# PHYSICS DATA SHEETS

## CONSTANTS

### Gravity, Electricity, and Magnetism

Acceleration Due to Gravity or Gravitational Field Near Earth .....	$a_g$ or $g = 9.81 \text{ m/s}^2$ or $9.81 \text{ N/kg}$
Gravitational Constant .....	$G = 6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$
Mass of Earth .....	$M_e = 5.98 \times 10^{24} \text{ kg}$
Radius of Earth.....	$R_e = 6.37 \times 10^6 \text{ m}$
Coulomb's Law Constant.....	$k = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$
Electron Volt.....	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$
Elementary Charge.....	$e = 1.60 \times 10^{-19} \text{ C}$
Index of Refraction of Air.....	$n = 1.00$
Speed of Light in Vacuum .....	$c = 3.00 \times 10^8 \text{ m/s}$

### Trigonometry and Vectors

For any Vector $\vec{R}$	
$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$	$R = \sqrt{R_x^2 + R_y^2}$
$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$	$\tan \theta = \frac{R_y}{R_x}$
$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$	$R_x = R \cos \theta$
$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$	$R_y = R \sin \theta$
$c^2 = a^2 + b^2 - 2ab \cos C$	

### Atomic Physics

Energy of an Electron in the 1st Bohr Orbit of Hydrogen.....	$E_1 = -2.18 \times 10^{-18} \text{ J}$ or $-13.6 \text{ eV}$
Planck's Constant.....	$h = 6.63 \times 10^{-34} \text{ Js}$ or $4.14 \times 10^{-15} \text{ eV}\cdot\text{s}$
Radius of 1st Bohr Orbit of Hydrogen .....	$r_1 = 5.29 \times 10^{-11} \text{ m}$
Rydberg's Constant for Hydrogen .....	$R_H = 1.10 \times 10^7 \text{ m}$

### Particles

Rest Mass	Charge
Alpha Particle.....	$m_\alpha = 6.65 \times 10^{-27} \text{ kg}$
Electron.....	$m_e = 9.11 \times 10^{-31} \text{ kg}$
Neutron .....	$m_n = 1.67 \times 10^{-27} \text{ kg}$
Proton.....	$m_p = 1.67 \times 10^{-27} \text{ kg}$

### Prefixes Used With SI Units

Exponential Value	Symbol	Prefix	Symbol	Prefix	Symbol	Exponential Value
$10^{-12}$	p.....	pico.....	$10^{-9}$	n.....	nano.....	$10^{12}$
$10^{-6}$	$\mu$ .....	micro.....	$10^{-3}$	m.....	milli.....	$10^6$
$10^{-2}$	c.....	centi.....	$10^{-1}$	d.....	deci.....	$10^2$
$10^1$	da.....	hecto.....	$10^3$	k.....	kilo.....	$10^9$
$10^6$	M.....	mega.....	$10^9$	G.....	giga.....	$10^{12}$
$10^{12}$	T.....	tera.....				

## EQUATIONS

Kinematics		Waves and Light		Quantum Mechanics and Nuclear Physics	
$\bar{v}_{\text{ave}} = \frac{\bar{d}}{t}$	$\bar{d} = \bar{v}_f t - \frac{1}{2} \bar{a} t^2$	$T = 2\pi \sqrt{\frac{m}{k}}$	$\frac{\sin \theta_1}{\sin \theta_2} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1}$	$E = mc^2$	$p = \frac{h}{\lambda}$
$\bar{a} = \frac{\bar{v}_f - \bar{v}_i}{t}$	$\bar{d} = \left( \frac{\bar{v}_f + \bar{v}_i}{2} \right) t$	$T = 2\pi \sqrt{\frac{l}{g}}$	$\lambda = \frac{\lambda d}{nl}$	$p = \frac{hf}{c}; E = pc$	
$\bar{d} = \bar{v}_i t + \frac{1}{2} \bar{a} t^2$	$v_f^2 = v_i^2 + 2ad$	$T = \frac{1}{f}$	$\lambda = \frac{d \sin \theta}{n}$	$F_v = \frac{kq_1 q_2}{r^2}$	$V = IR$
$v = \frac{2\pi r}{T}$	$a = \frac{v^2}{r}$	$v = f\lambda$	$m = \frac{h_i}{h_0} = \frac{-d_i}{d'_0}$	$ \vec{E}  = \frac{kq_1}{r^2}$	$P = IV$
Dynamics		Atomic Physics		Momentum and Energy	
$\vec{F} = m\vec{a}$	$F_g = \frac{Gm_1 m_2}{r^2}$	$\frac{\lambda_1}{2} = l; \frac{\lambda_1}{4} = l$	$\frac{1}{f} = \frac{1}{d_0} + \frac{1}{d_i}$	$I = \frac{q}{t}$	$F_m = IB_{\perp}$
$\vec{F} \Delta t = m \Delta \vec{v}$	$g = \frac{Gm_1}{r^2}$	$\frac{\lambda_1}{r} = l$	$\bar{E} = \frac{\bar{F}_c}{q}$	$  \vec{E}   = \frac{V}{d}$	$F_m = qvB_{\perp}$
$\vec{F}_g = mg$	$F_c = \frac{mv^2}{r}$	$F_c = \frac{mv^2}{r}$	$V = \frac{\Delta E}{q}$	$R = R_1 + R_2 + R_3$	$V = I \nu B_{\perp}$
$\vec{F}_s = -k\vec{x}$	$F_c = \frac{4\pi^2 mr}{T^2}$	$hf = E_{\frac{k}{\max}} + W$	$\frac{1}{\lambda} = R_H \left( \frac{1}{n_f^{\frac{1}{2}}} - \frac{1}{n_i^{\frac{1}{2}}} \right)$	$\frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{I_s}{I_p}$	
$\bar{p} = mv$	$E_k = \frac{1}{2} mv^2$	$W = hf_0$	$E_n = \frac{1}{n} E_1$	$I_{\text{eff}} = 0.707 I_{\max}$	$V_{\text{eff}} = 0.707 V_{\max}$
$W = Fd$	$E_p = mgh$	$E_{\frac{k}{\max}} = qV_{\text{stop}}$	$r_n = n^2 r_1$		
$W = \Delta E = Fd \cos \theta$	$E_p = \frac{1}{2} kx^2$	$E = hf = \frac{hc}{\lambda}$	$N = N_0 \left( \frac{1}{2} \right)^n$		
$P = \frac{W}{t} = \frac{\Delta E}{t}$					

# Periodic Table of the Elements

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	VIIA	VIA	VIIA or O
IA		IIA	IIIIB	IVB	VIB	VIB	VIB	VIB	VIB	VIIIB	IB	IB	IB	IB	VA	VA	VA	VIIA	VIA	VIIA or O	
<b>1 H</b>																					
1.01 hydrogen																					
<b>3 Li</b>	<b>4 Be</b>																				
6.94 lithium	9.01 beryllium																				
<b>11 Na</b>	<b>12 Mg</b>																				
22.99 sodium	24.31 magnesium																				
<b>19 K</b>	<b>20 Ca</b>	<b>21 Sc</b>	<b>22 Ti</b>	<b>23 V</b>	<b>24 Cr</b>	<b>25 Mn</b>	<b>26 Fe</b>	<b>27 Co</b>	<b>28 Ni</b>	<b>29 Cu</b>	<b>30 Zn</b>	<b>31 Ga</b>	<b>32 Ge</b>	<b>33 As</b>	<b>34 Se</b>	<b>35 Br</b>	<b>36 Kr</b>				
39.10 potassium	40.08 calcium	44.96 scandium	47.90 titanium	50.94 vanadium	52.00 chromium	54.94 manganese	55.85 iron	58.93 cobalt	58.71 nickel	63.55 copper	65.38 zinc	69.72 gallium	72.59 germanium	74.92 arsenic	78.96 selenium	79.90 bromine	83.80 iodine	126.90 tellurium	127.60 antimony	131.30 xenon	
<b>37 Rb</b>	<b>38 Sr</b>	<b>39 Y</b>	<b>40 Zr</b>	<b>41 Nb</b>	<b>42 Mo</b>	<b>43 Tc</b>	<b>44 Ru</b>	<b>45 Rh</b>	<b>46 Pd</b>	<b>47 Ag</b>	<b>48 Cd</b>	<b>49 In</b>	<b>50 Sn</b>	<b>51 Sb</b>	<b>52 Te</b>	<b>53 I</b>	<b>54 Xe</b>				
87.62 rubidium	88.91 strontium	91.22 yttrium	92.91 zirconium	95.94 niobium	98.91 molybdenum	101.07 technetium	102.91 ruthenium	102.91 rhodium	106.40 palladium	107.87 silver	112.41 cadmium	114.82 indium	118.69 tin	121.75 antimony	127.60 selenium	126.90 bromine	127.60 iodine	131.30 xenon			
<b>55 Cs</b>	<b>56 Ba</b>	<b>57-71</b>	<b>72 Hf</b>	<b>73 Ta</b>	<b>74 W</b>	<b>75 Re</b>	<b>76 Os</b>	<b>77 Ir</b>	<b>78 Pt</b>	<b>79 Au</b>	<b>80 Hg</b>	<b>81 Tl</b>	<b>82 Pb</b>	<b>83 Bi</b>	<b>84 Po</b>	<b>85 At</b>	<b>86 Rn</b>				
132.91 cesium	137.33 barium	178.49 hafnium	180.95 tantalum	183.85 tungsten	186.21 niobium	190.20 osmium	192.22 iridium	195.09 platinum	196.97 gold	200.59 mercury	204.37 thallium	207.19 lead	208.98 bismuth	(208.98) polonium	(209.98) astatine	(222.02) radon					
<b>87 Fr</b>	<b>88 Ra</b>	<b>89-103</b>	<b>104 Unq</b>	<b>105 Unp</b>	<b>106 Unh</b>	<b>107 Uns</b>	<b>108 Uno</b>	<b>109 Une</b>													
(223.02) francium	(226.03) radium		(266.11)	(262.11)	(263.12)	(262.12)	(265)	(266)													
<b>57 La</b>	<b>58 Ce</b>	<b>59 Pr</b>	<b>60 Nd</b>	<b>61 Pm</b>	<b>62 Sm</b>	<b>63 Eu</b>	<b>64 Gd</b>	<b>65 Tb</b>	<b>66 Dy</b>	<b>67 Ho</b>	<b>68 Er</b>	<b>69 Tm</b>	<b>70 Yb</b>	<b>71 Lu</b>							
138.91 lanthanum	140.12 cerium	140.91 praseodymium	144.24 neodymium	(144.91) promethium	150.35 samarium	151.96 europium	157.25 gadolinium	158.93 terbium	162.50 dysprosium	164.93 holmium	167.26 erbium	168.93 thulium	173.04 ytterbium	174.97 lutetium							
<b>89 Ac</b>	<b>90 Th</b>	<b>91 Pa</b>	<b>92 U</b>	<b>93 Np</b>	<b>94 Pu</b>	<b>95 Am</b>	<b>96 Cm</b>	<b>97 Bk</b>	<b>98 Cf</b>	<b>99 Es</b>	<b>100 Fm</b>	<b>101 Md</b>	<b>102 No</b>	<b>103 Lr</b>							
(277.03) actinium	(232.04) thorium	(231.04) protactinium	(238.03) uranium	(237.05) neptunium	(244.06) plutonium	(243.06) americium	(247.07) curium	(242.06) berkelium	(252.08) californium	(257.10) einsteinium	(258.10) terbium	(259.10) mendelevium	(260.11) nobelium	(261.11) lawrencium							

Key

3	Li
Atomic number	Symbol
6.94	6.94
Atomic molar mass	Name
lithium	lithium

(<sup>12</sup>C) Based on the most stable isotope



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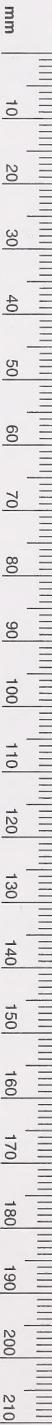
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